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UTILIZATION AND DISPOSAL OF POULTRY MANURE

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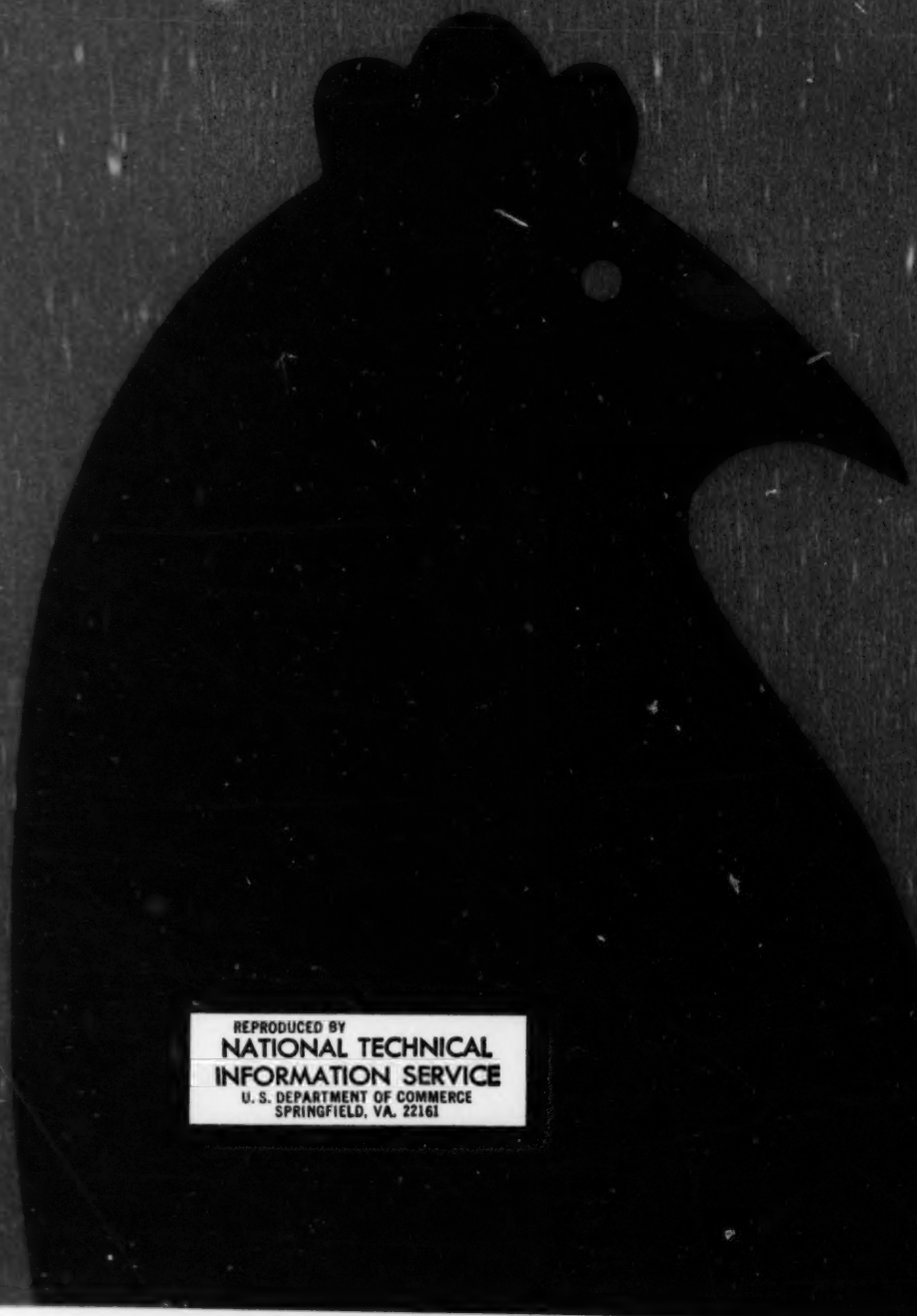

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UTILIZATION AND DISPOSAL OF POULTRY MANURE

John S. Wiley*

Our urban and suburban population growth has not only resulted in greater use and increased values of land but has greatly increased the quantities of solid wastes to be disposed of. While more people require greater food and industrial production, they also crowd out the farm and agricultural industry either by demanding lands for their own needs or by less direct means, such as annexing, zoning or claiming nuisance or health hazards. In many cases cities and suburbs are hard pressed to find suitable sites even for their own waste disposal.

Farming and agricultural industry have also expanded in the sense that individual installations become larger as smaller establishments are relinquished or consolidated. This compounds the waste disposal problems because more wastes are created per establishment, the nuisance and health factors are accentuated, and the premises are no

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longer isolated from habitation. Disposal on land becomes less and less practical either because of costly handling distances or increased land values. Both cities and agriculture are running out of "waste" land that may be used for solid waste disposal.

The Orange County Problem

An extreme example of the problems of disposal of poultry manure is found in Orange County, California, where many egg ranches are now engulfed by cities or developed areas. Donald Bell, Orange County Farm Advisor, recently counted 189 poultry ranches in the county with a total of 2,528,000 hens. While quite a few poultrymen have gone out of business or moved out of the county, he estimates that, in 6 to 10 years, the number of poultry ranches will decrease to approximately 40 with about one million hens. The average ranch size in 1962 was 13,376 hens, with 45 percent of the ranches having 80 percent of the chickens in the county. Now the 84 ranches within city boundaries in Orange County average 14,730 hens per ranch. The main environmental problems created are the production of flies, odors, feathers, and dust. As most poultry houses are of open construction without screening, the fly problem (principally, Fannia species) is so pronounced that a research project on "Fly Control Methods Pertaining to Poultry Operations" has received the support of the California Department of Public Health for pursuit by the Orange County Health Department.

The Orange County ranch houses generally have single cages with 1 or 2 birds or 80-bird group elevated cages with cleanout ranging from twice weekly to twice yearly. While daily to twice-weekly cleanout will greatly reduce the fly problem in the house, it will not necessarily do so on the ranch. Some of the worst conditions occurred on ranches with 3- to 7-day cleanout schedules, but with only weekly pickup of the manure. The larger piles produced many more flies than the smaller amounts of manure beneath the cages. Conditions at the manure stockpile area, a cooperative operation by Poultry Fertilizer Disposal, Inc., varied from intensive fly breeding in wet manure to excessive dustiness from dry manure. A big problem in Orange County stems from lack of knowledge by entomologists of the life history, habits, and ecology of Fannia species; even attempts to rear it in the laboratory have failed.

Composting

Composting is the term used to describe the aerobic, thermophilic decomposition of organic wastes to a relatively stable humus. Decomposition results from the biological activity of microorganisms which exist in the wastes. The microorganisms involved are primarily bacteria, actinomycetes and fungi. If adequate air is supplied, aerobic types of microorganisms predominate that use oxygen in their respiration and metabolism, giving off CO_2, H_2O, and heat. They convert complex organic materials, such as carbohydrates and proteins to simpler organic compounds such as acids, bases and salts and, finally, to inorganic substances and stable humus. The resulting compost may contain up to

25 percent dead or living organisms and is subject to further, slower decay but should be sufficiently stable not to reheat or cause odor or fly problems, even when it is moistened and stacked.

A wide variety of organic wastes can be composted but the raw mixture must meet certain requirements and the undertaking requires a certain amount of "know-how" and attention. Even when conditions are right, the wastes may quickly become anaerobic with disastrous results if the compost is not adequately aerated or if it becomes excessively wet. The most important criteria for successful composting are: (1) suitable structure; (2) adequate aeration; (3) proper moisture content, and (4) a reasonable range of nutrients, principally carbon and nitrogen. Obviously, no material in the composting mixture can be present in sufficient quantity to be toxic to the decomposing micro-organisms. Most municipal refuse, agricultural wastes, or residues from food processing do not contain enough poisonous matter to be a problem.

Suitable structure involves the proper range in size of particles and in pore space of the composting mixture. Wastes such as kitchen garbage, sewage sludge, and certain fruit and vegetable wastes may not have good structure, even if dried to the proper moisture content, because of the gelatinous nature of the solids of excessive fines. The more open-textured the mixture, the better the aeration that can be achieved, either in enclosed composters or in open windrows or bins. Pile and windrow composting experiments with ground garbage at San Diego[1, 2] showed

that garbage was too wet and had too poor structure for aerobic composting. Even the addition of 10 percent paper did not adequately improve the structure or reduce the moisture content. After having been composted for about three months with as many as 30 turnings, the San Diego garbage was still inadequately decomposed. There have been other reported failures because of attempts to compost materials with excessive moisture content or insufficient voids for the transfer of air, notably: the Earp-Thomas plants at Michigan State University,[3] at Kobe, Japan,[4] and at Reading, Pennsylvania,[5] and the Frazer-Eweson plant at Springfield, Massachusetts.[5]

Agricultural wastes with poor structure are such materials as tomatoes, fruits,[6] and other succulent vegetables. Those of good structure consist of woody wastes, most manures,[7,8] rice hulls,[6] coffee grounds, cotton gin trash,[9] and most stalks,[8] stems, leaves,[10] and cobs.[8] While most manures will compost by themselves, for reasons given later, it is better not to attempt it with chicken manure from caged birds.

Adequate aeration involves the provision of enough air so that there will be some excess of oxygen to provide aerobic conditions at all times throughout the mass. It also involves the adjustment of air, when suitable controls exist, to sweep out the moisture produced and to evaporate some of the existing moisture, preferably so that the percent moisture in the composting mixture does not change. Excessive aeration causes rapid drying and also cooling of the mass, or drying in the latter stages of composting or curing.

In some mechanical units, such as the towers of the Jersey or the Naturizer systems, sufficient air is provided by the heat generated by the compost and the chimney effect. In some other systems, the air is provided by means of blowers. Experiments at Chandler, Arizona, by the Public Health Service, showed that natural ventilation of the ground refuse piles only occurred effectively for a distance of about 15 inches. Capitalizing on this finding, Maier developed "aeration bins" which provided material exposure to the atmosphere on all six sides and, because they were only 30 inches wide, aeration was adequate at all times throughout the mass.[11] In Europe, the author saw[12] windrows of all sizes from about 1 meter high to about 10 meters high, but the Americans favor windrows of trapezoidal shape that are about 5 ft high and 7 ft wide at the base. Admittedly, parts of such a windrow would become anaerobic in less than a week and, for this and other reasons, frequent vigorous turning is necessary. Turning accomplishes reaeration, mixing, gradual particle-size reduction, and exposure of new matter to microbial attack. It also serves to adjust moisture, provided a suitable watering device is used. While the temperature drops during turning, it immediately rises, often to higher levels than before. Oxygen is rapidly utilized and, although the compost process would benefit by daily turning, it is not essential if other factors are properly adjusted. Oxygen levels during the runs with both windrows and bins at Chandler were less than 2 percent by volume in the air a foot or more deep in the piles but only went to zero once or twice in the hundreds of tests.[13]

There was, however, occasional disagreeable odor on turning and re-grinding the compost. Flies or other vermin were never a problem.

Proper Moisture Content. This is the most important criteria for optimum composting. A little too much moisture and the composting material quickly becomes anaerobic, causing odors and a marked slow-down in the rate of decomposition. For example, experience at Michigan State showed that composting plant odors are not treated lightly by either college students or the general public. At one of the latest U.S. refuse composting plants, the author observed that water could be squeezed out of the compost at any stage in its processing beyond the biostabilizers. The odor remains and persists until the material is turned many, many times and the moisture level is suitably reduced. The "squeeze test" appears to be a good, practical test for suitable moisture content.

Although there is great danger from too much moisture, there is no danger from too little. Even at 25 percent moisture, which is supposed to be far below the value for any pronounced biological action, the compost may be too hot to touch. Also, in the later, drier stages of the composting the thermophilic actinomycetes and fungi are at work on the more resistant organic matter, such as celluloses and lignins. These do not cause trouble but, if decomposed sufficiently, will form a relatively stable, long-lasting humus. The fungi especially like the cooler, drier portion of the piles, as is shown by pronounced familiar gray actinomycetes' growth.

Reasonable Range of Nutrients. This is, of course, necessary for both plant and microbial life to thrive and to produce. Fertilizers provide

the major nutrients and some, possibly, supply the minor or trace elements. While composting will handle a very broad range of nutrients, either slowly or rapidly, it is better to have a reasonable range in the raw mixture, even if it requires adding other wastes high in the desired constituents. For example, sawdust decomposes very slowly over a matter of years, simply because of a nitrogen deficiency. Add a little high-nitrogen chicken manure and decomposition speeds up. Raw chicken manure, on the other hand, has too much nitrogen to compost alone without loss of nitrogen. Therefore, in the interest of economy, it is better to add dry wastes to wet chicken manure for two important reasons: reducing the moisture content, and producing the most high-quality compost that can be made from the manure.

The carbon-nitrogen ratio (C/N) is emphasized by composters. The ratio for sawdust is about 500:1; for chicken manure (fresh) it is about 10:1. Microorganisms themselves are about 5:1 to 12:1, and so is well-rotted humus. With high C/N refuse, say, 80:1, decomposition will be prolonged because of a shortage of N and a need for future generations of microbes to obtain their nitrogen by recycling it from dead organisms.

While trace elements are very important to the farmer and agronomist, they are not so important in the microbe world. There are many organisms that can live off one single nutrient or compound. There never seems to be a shortage of microorganisms if conditions are right for their growth. Manure, soil, sludge, garbage, and refuse all teem

with organisms so that one need not add enzymes or bacterial "starters" to make a compost heap start to heat. Only in extreme cases need there be any inoculation, such as legume grown on soil devoid of nitrogen-fixing organisms. As for trace elements that benefit plants, there seem to be ample supplies of them in refuse compost and, presumably, in composted chicken manure.

Poultry Waste Disposal. Speaking only of the manures from chickens, the easiest to handle, and causing the least problem of flies and odors, is the deep litter manure from ranches where the birds are on the floor. These are generally all ranches except the egg producers, in California. They include: fryer, broiler, pullet, and hatchery egg producers. Our attention must therefore by focused on the egg ranches where caged birds are kept off the floor, and no litter or floor birds are used.

Except for disposal of manure by means of a water-carried system, some form of composting or air-drying is generally practiced. Most egg ranches in the drier parts of California attempt to dry the droppings as rapidly as possible, often installing wooden slats or wire cones beneath the cages to provide better aeration. Most of these, however, are unsatisfactory because the drying does not occur in the 5- to 7-day period required for complete fly development.

Such houses, however, do permit a partial composting of the manure in place. Therefore, when we consider manure treatment we must include the treatment under way naturally beneath the cages as well as that after its removal. Methods of removal and removal frequency both play

important parts in the disposal of wet manure. In California, removal periods vary from twice a week to twice a year. The manure in the former is exceedingly wet, odorous and a potential fly breeder, while that in the latter is usually dry, dusty and disperses feathers.

There are possibly a half dozen different types of undercage manure cleanout machines. These vary from plain scraper blades to elaborate mechanical or hydraulic pickup devices with or without arrangements for retraction around posts or other obstructions. Belt conveyors with scrapers have been tried in many instances, but have been discarded as being too expensive or mechanically unsatisfactory. Many ranchers use hand removal with shovels and wheelbarrows. An extreme example of this exists at the 240,000-layer La Torre Ranch which requires nine man-days or $90 per day for manure cleanout to maintain a 10-day cleanout schedule. Everything else at La Torre is mechanized.

Tests by the State Department of Public Health in California indicate that twice weekly cleanout during the fly-breeding season is essential for the open type of house. This does not necessarily eliminate flies from the ranch; in fact, one of the worst fly problems occurred when the manure was removed twice weekly, but was only picked up by the haulers on a weekly basis. Under these conditions, there seemed to be larger numbers of flies, which apparently developed in the large manure piles on the ramps, rather than in the manure beneath the cages. The solution, of course, is the prompt removal of manure from the ranch and, incidentally, the avoidance of double handling where possible.

The best solution for treatment and disposal of wet manures appears to be by means of a cooperative which would do the hauling and processing rather than by individual ranchers. Even the largest ranch produces only a small number of cubic yards of manure daily. However, a cooperative could handle wastes from a number of larger ranchers and could treat and dispose of the manure more economically.

One good arrangement is the composting of manure from cage houses together with manure from litter houses, thus mixing the wet with the dry and obtaining better structure, pore space, particle-size distribution, aeration and moisture control. In regions where only egg ranches exist, the problem resolves itself into finding suitable dry wastes with which to mix the wet manure. In many areas of California such wastes as sawdust, rice hulls, coffee grounds and cotton gin trash are readily available and might even be obtained at a profit rather than a cost. Attempts to dry the wet manure alone are bound to be expensive. It also does not seem to pay to attempt dewatering of the manure.

At the risk of criticism by the poultrymen, the writer suggests that the ideal solution for egg ranches would be to use the deep litter method, just as in the fryer ranches, and to utilize either fryers or cockerels, which may even be discarded later, on the floor. With this system it may only require about one male bird on the floor for every ten hens above, and fly, odor, or dewatering problems will be reduced. With the deep litter, the litter can be either changed completely once

every two years or approximately one inch removed after each brood with replacement by fresh litter.

The deep litter system for caged birds could, theoretically, be applied over the entire floor or only beneath the cages. In the former, it would be preferable to have complete mechanization, including mechanical egg retrievers. In the latter the aisles would be clear for feeding or egg retrieving, but either fencing or slats would be required around each caged row or double row.

Manure may, of course, be applied directly to the land, but this is usually not practical because of seasonal demand or spreading difficulties. Even manure that is dried presents problems of dust in spreading. While composting will reduce spreading difficulties and nitrogen percentages, it need not result in an overall loss of the nitrogen weight. By the composting of mixtures of chicken manure with low-nitrogen waste more compost is produced and more nitrogen saved than by composting straight chicken manure.

The final consideration is that poultrymen must accept the fact that they must pay for waste disposal along with other costs of egg production. One might not expect a profit by composting, but on the other hand, this procedure appears to be the most economically feasible method of treatment and utilization of poultry manure.

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